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REVIEW AND SUMMARY OF X-20 MILITARY APPLICATION STUDIES

14 December 1963

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X-20 SYSTEM PROGRAM
AERONAUTICAL SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE

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Introduction

Since April 1952 when the Bell Aircraft Company offered a proposal to the Air Force for a manned bomber-missile (BOMI), interest and progress in the study and analysis of manned hypersonic glide vehicles and lifting-reentry space systems such as the X-20 Dyna-Soar have continued within the Air Force. Two general categories of applications of such systems have been considered. First, the application to military space operations and second, the application or use for purposes of research, advanced development, and extension of technology in the environments of hypersonic, reentry flight and of earth-orbit.

The purpose of this memorandum is to review and summarize the significant technical and programming studies relating specifically to the X-20 Dyna-Soar which have been performed in the first application category only, that of military operational applications. Included in this category are studies of X-20 systems which assumed experimentation and testing peculiar to military applications as a mission objective, since successful completion of such missions could readily provide an interim, partial, operational capability.

A summary of the progression and inter-relationship of the military application studies conducted by and for the X-20 SPO is given first, then resumes of the major studies and some related studies are presented in this paper.

Summary

The initiation of the Dyna-Soar program was for the most part based on operational weapon systems studies. Development directive No. 94 and System Development Directive 464L in 1957, were founded on the results of studies and plans accomplished by the Bell Corp on projects BOMI (bomber-reconnaissance) and BRASS BELL (reconnaissance), by seven contractors on project ROBO (bomber) and by the Government on HYWARDS (research system) between 1954 and 1957. These results were integrated and incorporated in the first Dyna-Soar development plan, which was approved in November 1957 and which formed the basis for a competitive 464L boost glide weapon system definition study by Boeing and Martin in 1958 and early 1959. These studies were conducted simultaneously with the Phase 1 system definition studies. The results of the boost-glide studies, which are summarized in the resumes, defined in general terms a manned, medium L/D, lifting reentry vehicle concept which was optimized for a program which started with orbital research and development testing and proceeded to development of a reconnaissance and orbital bombing system. More detailed and specific studies of operational requirements were indicated as necesssry in the conclusion. DOD redirection of the program to emphasize manned hypersonic research resulted in initiation of a "step" development program, i.e., Step I, suborbital research; Step IIA orbital military testing; Step IIB, interim operational capability, Step III full operational capability. Upon completion of 'Phase Alpha' configuration reappraisal, approval was requested and obtained for the Step IIA and Step IIB program definition and system analysis studies. Step IIA planning studies were directed at defining an orbital-military test program which developed and demonstrated man-machine capability in the orbital and reentry regimes and which demonstrated the capability of the X-20 for testing of military and

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scientific equipment and subsystems in the orbital and reentry regimes.

The results of Step IIA studies were based on the mission and system requirements developed from the Step IIB technical analysis studies, as well as on other related studies cited in the bibliography of reference 6 of resume II.

The Step II studies were conducted during a continuing cycle of appraisal and modification to the basic Dyna-Soar program. Work done in the studies contributed strongly to formulation of program proposals such as Streamline and Manned Military Space Capability (resume V) and influenced the decision to redirect the program to orbital capability during Step I. These studies detailed test and interim operational vehicles having up to 24-hour duration and clearly demonstrated the requirement to reduce vehicle weight on orbit by modifying the abort propulsion subsystem. A precise definition of military subsystems and equipments suitable for Dyna-Soar testing was obtained. Several problem areas associated with orbital flight were defined and the requirement for launch vehicles having a capability greater than the standard Titan IIIC identified for interim operational capability.

Although the Step II studies had been directed to military applications, the nature of the basic Dyna-Soar program was directed in 1962 toward the objective of multi-orbit and reentry research, the Dyna-Soar was designated X-20 and study work on military applications was eliminated by DOD direction. Only general planning, such as given in resume VII was accomplished. In March 1963, however, the Secretary of Defense questioned the military potential of the X-20, such that the studies described in resume III were initiated. These studies, although severely limited in scope by lack of study funds, essentially updated the knowledge gained in the Step IIA and Step IIB studies, showed potential military advantages and capabilities of the X-20 in four mission applications, and provided specific capability comparisons of the X-20 and the Gemini systems in the performance of inspection and reconnaissance missions.

In the atmosphere of growing national acceptance of military use of space in 1963, consideration of a military or orbital equipment test mission for the X-20 again appeared logical and studies such as described in resumes VIII and IX were prepared by the Air Force. Various X-20 SPO in-house analyses to study the operational advantages of such factors as high L/D and synergetic maneuvering were also prepared. The last major military capability study, given in resume IV, was prepared in response to an Air Force directive that a Phase 0 study should be initiated to define an X-20 system concept and development plan to accomplish the Program 706 mission. This study was conducted within a very restrictive set of ground rules to facilitate evaluation of competing systems. Some of these ground rules required that 14-day, 2-man mission capability be demonstrated by the X-20 with the result that the first specific X-20 vehicles for relatively long duration in-orbit were configured. This study also provided a detailed definition and development plan for an advanced guidance system, a study of man's capabilities and role in the inspection mission, and detailed performance trade studies of X-20 vehicles configured for 3-days and 14-days operating from the Titan IIIC launch vehicle.

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It is to be noted that many studies have shown the flexibility, utility and feasibility of the X-20 vehicle configuration for military applications. Of the missions studied, the use of the X-20 for reconnaissance appears the most effective. However, the capability for other missions of inspection, logistics and military testing appear entirely adequate for early operational needs, particularly when the unique military advantages of the X-20 are considered. Studies have shown these to include: ease of payload conversion; low G, controlled reentry; large return payload; large landing footprint with no requirement for large numbers of landing sites and recovery aids; quick landing-return capability and accumulation of technical and operational knowledge pertinent to potential future vehicles such as aerospace planes, recoverable boosters, and super-orbital reentry vehicles.

Resumes of Individual Studies

Four major military application studies have been conducted under the direction of the X-20 SPO, at an expenditure of approximately 0.6% of basic program funds. These are tabulated below and described in the resumes which follow:

I Boost Glide Weapon Systems Application Study - June 1958.
II Dyna-Soar Step II Studies - October 1960.
III Response to Secretary McNamara's 15 Mar 63 Questions - Oct 1963.
IV Phase O Study of X-20 for Program 706 - Nov 1963.

Other related studies involving the X-20 have been devoted either to military capability or program planning. These also are listed below and briefly described in the following resumes:

V Dyna-Soar Manned Military Space Capability Study - September 1961.
VI SR-178 Global Surveillance System - Nov 1960
VII USAF Space Program - Oct 1962.
VIII (S) X-20 Anti-Satellite Mission - June 1963.
IX President's Scientific Advisory Council Questions - Oct 1963.

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Resume I

BOOST-GLIDE WEAPON SYSTEMS APPLICATION STUDIES

A. Introduction

During the period of June 1958 through June 1959, Boost-Glide Weapon System Application Studies were performed under two separate programs. Under SR-126, Lockheed, Marietta, accomplished an unfunded study and under the Dyna-Soar 4641 system, two contractors, Boeing of Seattle and Martin of Baltimore, accomplished funded studies. These studies were conducted, under separate contract, simultaneously with the Phase I contractor source selection programs. Funding level was $800,000 each to The Boeing Company and to Martin-Marietta. An Air Force team at ASD evaluated the various studies during October 1959.

B. Objectives

The objective of this study was to determine the military weapon system applications of the boost-glide technology. In addition, this study was to provide early guidance as to what technical developments will be required to assure that these weapon systems can be available in the specified time period.

C. Scope and Limitations

The scope of this study included consideration of all military applications from short-range, boost-glide missions to those systems having extended life in orbit. Time allocated for the study was one year. Both manned and unmanned bombers were considered.

D. Conclusions

Pertinent conclusions and recommendations included:

1. The Dyna-Soar's re-entry maneuverability characteristic provides by far the best known means of integrating man into an operational space force.

2. The basic Dyna-Soar test vehicle can provide an early manned, all-weather reconnaissance capability, and an early means to gain experience in operational logistic support and intercept missions.

3. Studies should be implemented leading to a development plan to provide a Dyna-Soar interim operational capability to perform reconnaissance and inspector missions.

4. Feasibility of a multi-purpose boost-glide vehicle should be studied to perform military missions such as reconnaissance, offensive, defensive and support.

5. Of all the advanced system application concepts studied, the potentialities of hypersonic boost glide vehicles for military reconnaissance are most outstanding.

6. Schedules and Costs:

The following schedules and costs are taken from results of the Boeing Company study of the Satellite Inspector Application. They are based on a booster having a minimum capability of placing 15,000 pounds payload in a 400,000 feet orbit and mission time of 24 hours with a 12-hour reserve.

Schedule:

Interim Operational - start May 1962; end late 1962.
Operational - start late 1962

Cost:

The ground rules on which the costs were based are included in Boeing report but are too detailed for this summary. The costs are:

Estimated costs for Demonstration Program	$491 million
Estimated costs for Operational Program,	
Interim (Titan)	2,086 million
Ultimate	1,889 million
Interim (Saturn)	1,974 million

E. References

1. The Boeing Co. Doc. D27-1048 (Vol. I) Boost Glide W/S Application Study Summary Report - June 1959

2. The Martin Co. Doc. ER-10437-1 - Boost Glide W/S Application Study - June 1959

3. WADD Technical Report 60-710, Evaluation of Boost-Glide Weapon System Application Studies - September 1960

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Resume II

DYNA-SOAR STEP II STUDIES

A. Introduction

The Dyna-Soar Step IIA and IIB studies were conducted by The Boeing Company between October 1960 and June 1962 under Contract AF33(600)-42496 (CCN No. 1) funded at $1.33 million. These studies were authorized by Systems Development Requirement No. 19 and Development Directive No. 411. A proposed Step III study to establish an X-20 full-operational concept and plan was not implemented because of non-availability of funds.

B. Objectives

Step IIA study objectives were to identify mission requirements for testing military equipments, define flight profiles and vehicle interface requirements, and to demonstrate the capability and potential of Dyna-Soar for military applications and scientific research.

The study objectives of Step IIB were to determine the operational concepts, system preliminary design, and to define subsystem and equipment for weapon systems aimed at Satellite Interceptor/Inspector, Space Logistics and Bombardment.

C. Scope and Limitations

The study encompassed preliminary test mission requirements, flight profiles, design modifications, booster requirements, system support requirements, problem areas and operations analyses to determine specific concepts of operation as pertains to Reconnaissance and Satellite Inspector/Interceptor, Space Logistics & Bombardment, program cost and timing and a comparison with other weapon systems in the 1965-1970 time period.

The study was limited to specific weapon systems which could provide early operational capability (1965-1970), using Step IIA hardware with minimum modification. The system was to be manned and use the Titan III as a booster. A maximum mission duration of 24 hours was determined as a requirement from the Step IIB mission analyses and the vehicles were configured for 14 and 24 hour capability.

During this study time period, performance analyses using the Titan III launch vehicle could not be completed with the degree of precision desired, selection of the T-III final configuration having occurred rather late during the Step II Study.

D. Conclusions

Technical:

Dyna-Soar's unique capability to accommodate the payload module concept allows reconnaissance missions (photo, elint, radar) and rendezvous missions (inspector, interceptor, logistics) to be performed with one basic vehicle.

The Satellite Interceptor/Inspector mission using the Dyna-Soar vehicle is considered feasible and within the technical state-of-the-art for the 1965-1970 time period. It is well suited to the Satellite Interceptor/Inspector mission; its aerodynamic lateral maneuverability may be utilized to minimize return time from orbit and the number of landing sites required. In addition, man is considered the primary element in obtaining inspection data. He can also control the final phases of rendezvous and may be the best control element for the station keeping phase. The Satellite Inspector mission will be required because the Soviet's real and reputed capability in space poses a military threat and is a political weapon, hence the following postulated missions could become operational requirements:

1. Checking of enemy claims relative to space technological accomplishments.

2. Inspection of unknown space objects.

3. Neutralization of space vehicles which are considered a threat to the United States.

The Titan III booster has sufficient capability to permit rendezvous with virtually any satellite whose orbital altitude is 80 to 600 N.M. and whose orbital inclination is between 35° eastward and 35° westward. (NOTE: This performance was based on a booster payload capability of 30,200 pounds, later reduced to 26,000 pounds). The first interim operational capability flight of a Satellite Inspection mission can be conducted in August 1968.

Only a limited effort was devoted to study of concepts for logistics and shuttle applications. However, the development of a useful Space Logistics System, with capability of rendezvous, docking, transfer and mooring techniques, appears feasible. The application of Dyna-Soar to these techniques coupled to its inherent capabilities for pilot de-orbit and reentry maneuvering and landing at precise earth locations makes it suitable for such missions as supply and maintenance of satellites, in-space assembly of large satellites, rendezvous training, or reentry assist, with the addition of 1 or 2 more crew members.

Schedules:

The study included schedules that were sequential to, or over-lapped, the then current flight schedule.

	Current Program	Option 1 (Sequential)	Option 2* (Overlap)
First Unmanned Flight	1965	1965	1965
Tenth Flight	1967 (early)		
First Multi-orbit Flight		1967 (middle)	1965 (late)
IOC System Available		1968 (early)	1966 (late)

(*) Not limited by manpower or funding

Cost Summary:

Total costs of the various optional development and demonstration flight test programs were summarized as follows:

Program	No. Flights	Total Cost*	No. Gliders New	No. Gliders Refurbished
Reconnaissance	9	$386 million	3	4
Interceptor/ Inspector	6	281 million	2	4
Space Logistics	7	302 million	2	4

(*) Includes indirect costs covering range, AFSC centers, Navy and common support.

E. References

1. Boeing Doc. D2-7915-1 Definition of Military Subsystems for Dyna-Soar Step IIA Testing.
2. Boeing Doc. D2-80292 Provisions in Step I glider for Step IIA Military Subsystem Testing - June 1961
3. Boeing Doc. D2-80490-1 Dyna-Soar Step IIA Planning & Analysis System Package Program for Step IIA - June 1962
4. Boeing Doc. D2-80289-2 Dyna-Soar Step IIB Studies Summary Report - June 1962
5. Boeing Doc. D2-80678 Dyna-Soar Step II Program Cost Estimates - June 1962
6. X-20 SPO Report, ASD, Evaluation of the Dyna-Soar Step IIA and IIB Studies, 62ASZR-1996, December 1962

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Resume III

X-20 MILITARY CAPABILITY STUDY IN RESPONSE TO SECRETARY McNAMARA'S 15 MARCH 1963 QUESTIONS

A. Introduction

A paper was prepared under the direction of Hq AFSC by the Space Systems Division acting as lead division during March-May 1963, with support by ASD and ESD. The purpose of this paper was to respond to a memorandum of 15 March 1963 from the Secretary of Defense. Under the technical direction of X-20 SPO, an X-20 mission capability study was performed by The Boeing Company (under CCN-38, Contract AF 33(657)-7132) to support ASD participation in this study.

Study results were published in a two volume report, "Response to Secretary McNamara's 15 March 1963 Questions," dated 10 May 1963 (SSTS-85).

B. Objectives

The objectives were to (1) examine the contributions that the X-20 and Gemini systems could make to each of four missions:

a. The inspection and destruction of hostile satellites.

b. The protection of our own satellites from destruction.

c. The capability of carrying out reconnaissance from space.

d. The introduction of offensive weapons into near-earth orbit.

(2) To up-date and extend the Step II study results in accord with common study ground rules and new system requirements data.

C. Scope and Limitations

This study included a treatment of the contribution potential of the X-20 present program towards performing cited military missions; also, described is a 14 flight program employing a Dyna-Soar modified glider designed to provide an IOC for 3 military missions. Lastly, an analysis of the contribution toward extended mission capability of a modified X-20 launched by a mature Titan III booster. Several constraints were applied to this study: mission models, launch azimuth, vehicle payloads, launch vehicle payload, orbital duration of at least 24 hours with potential for two weeks.

D. Conclusions (Summary)

1. Contributions of the present Dyna-Soar program are limited to:

a. Technology and experience broadly applicable to manned orbital flight in all mission areas. The X-20A contributes, mainly, aerodynamic maneuvering reentry technology.

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b. Basic hardware which can be modified in possible future programs to have more specific contributions to the military missions cited in the 15 March memorandum.

2. Neither vehicle (the X-20A or Gemini), without modification, can fully qualify for any military mission as a space system functioning on a routine basis.

3. The lifting reentry technology to be derived from the X-20 program is mandatory in order to achieve operationally effective military space capabilities.

4. Regarding possible future programs using Dyna-Soar vehicles, indications are that the X-20 can better contribute to the request reconnaissance mission in the near future, since this mission does not demand as much in the way of payload and on-orbit maneuvering or mission duration as do the other missions, but does require return of data to a secure military base equipped to process it in a minimum time.

Conclusions (General)

1. Contributions to military missions by the present X-20A program:

a. The contribution to military missions capability of the currently active and funded X-20A are aimed primarily towards the development of technology and basic capabilities essential for future military space operations and the provisions of basic hardware, which can be adapted or modified in new programs to test military subsystems and perform limited operational missions.

b. X-20A contributions emphasize the development of highly flexible, controlled aerodynamic maneuverability capabilities to reduce orbital waiting time and permit landing at a selected site on earth, and the attendant research of hypersonic flight and related high temperature structures and materials technology. In addition, the spacecraft contains adequate internal volume, payload capacity, power and cooling for a large number of possible military components or subsystems for tests or operations, with the capability of returning the test or mission subsystems to earth for reuse. Operational experience in space and the demonstration of flexible reentry capability by the Air Force will be an important result of the flight program.

2. Contributions of Expanded X-20A Flight Programs:

a. The possibility of expanded flight programs exist, either involving inclusion of military experiments in current flight programs (no major spacecraft modifications) or additional flights of the same spacecraft.

b. Experiments and tests of larger military components and subsystems are possible on the X-20A. The payload space and weight capability of the X-20A, and its payload return capability provide the means for orbital tests. Additional flights of the X-20A beyond the 10 currently programmed may be warranted

for test and demonstration of military subsystems and mission capabilities and/or additional hypersonic research. Subsystems packages for reconnaissance (high acuity camera, elint, high resolution radar) or inspection sensor subsystems may be carried internally.

3. Contributions of modified X-20 in possible future programs:

a. In addition to contributing further to the national fund of technology and experience applicable to manned space flight generally, modified versions of Dyna-Soar vehicles in new programs can make direct contributions to military mission areas by serving as flight test beds for military mission subsystems or as elements of complete military mission test systems, and as such, can have varying degrees of limited operational capability. However, neither vehicle (the X-20 or Gemini) can, through modification, acquire all the characteristics desired of a military space system for routine operational use.

b. The X-20 with only minor adaptations can be utilized to test reconnaissance, inspection and other military subsystems. To improve on-orbit maneuvering and payload capacity enough to permit adequate tests of complete mission systems in possible future programs, or to perform limited operational missions, unnecessary weight must be eliminated by a series of modifications which have been identified and are technically and economically reasonable.

c. The principal inherent advantages of a modified Dyna-Soar for possible future military mission programs are:

(1) High aerodynamic lift/drag reduces the post-target on-orbit waiting time before return to a secure military base can be effected, thus reducing exposure to enemy discovery and action, and insuring earlier data recovery.

(2) Probability of landing in a reusable condition at a secure military base is enhanced by:

(a) Exploiting high available lift/drag ratio to make major adjustments to flight path during re-entry to correct errors in initial re-entry course.

(b) Relatively high and broadly variable landing approach speeds with continual positive control and good flight maneuverability which minimize the problem of winds, weather and errors in track. In contrast, land recovery of Gemini in reusable condition is still questionable.

(3) Large landing footprint afforded by high lift/drag ratio increases probability of a safe landing in friendly territory in event of an emergency re-entry.

(4) Low deceleration during re-entry reduces strain on crew.

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(5) X-20 can accommodate in its internal payload compartment all or a major proportion of the military mission subsystems carried, and returns them from orbit for examination and reuse. (Dyna-Soar can return from orbit about 5 times as much weight as can Gemini.)

(6) The X-20 appears to have growth possibilities which may give it the capability to mount internally, bulkier mission systems packages to take advantage of a potential capability to return a 4,000 pound package from orbit.

(7) Cost factors favoring a modified X-20 are:

(a) Vehicle reuse factors several times higher than Gemini.

(b) Appreciable flight testing of mission subsystems can be done in the course of the 10 presently programmed re-entry research flights.

(c) Mission subsystems carried internally can be reused.

(d) The X-20 is already mated to the Titan III-C.

(e) There is no known way in which either a modified Gemini or X-20 can provide a means for introducing offensive weapons into earth orbit which will result in an operational capability competitive with present ballistic systems. The re-entry technology gleaned from the present X-20 program may prove helpful in the design of guided glide weapons which may have future possibilities.

(f) The capability for executing evasive maneuvers in orbit is possible with mission systems using modified versions of either X-20 or Gemini. In addition, either vehicle can be used as a test bed for developmental efforts on other survivability improvement techniques such as decoys, shielding, observable alteration, ECM, etc. The X-20 possesses a potential for self-protection not inherent in Gemini to the extent that its superior emergency orbit return and atmospheric maneuvering characteristics can be exploited for enhanced survivability.

(g) Although a manned space station was not mentioned as a mission in the memorandum, these spacecraft may be adequate for shuttle purposes if they are suitably modified. The weight advantage favors Gemini, while the capability for precision recovery favors the X-20. Also the X-20 may be modified to carry in addition to the pilot, up to four passengers in the pressurized payload compartment.

(h) Regardless of launch vehicle, loss of operational coverage will be suffered unless present flight safety azimuth restrictions are waived, or a new launch base is established, free of such restrictions. This loss can be diminished by turning during booster operation. By using X-20 lift, the loss can be further reduced. A PMR launch complex is necessary unless a new complex is built free of azimuth restrictions.

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Schedule and Cost:

The schedule and cost were based on an integration and extension of the X-20A R&D program. Mission subsystems were to be tested on six (6) multi-orbit flights and two (2) more flights were to be added to demonstrate ability of the X-20A spacecraft to accomplish common reconnaissance or inspection missions. The additional flights would be accomplished with refurbished gliders.

First air launch - March 1965!
First unmanned ground launch - January 1966
First piloted ground launch - July 1966
First multi-orbit flight - August 1967

Cost Summary:

Based on the ground rules used for the study, total costs necessary to augment the X-20A program for subsystem testing are summarized. Included are costs of two additional flights to demonstrate ability of X-20 spacecraft to accomplish the common reconnaissance or inspection mission. Costs associated with an additional 20-flight operational program are also shown.

X-20 Fiscal Year Summary (Dollars in Millions)

MISSION		FISCAL YEAR 64	65	66	67	68	69	70	71	72	
Reconnaissance											
	T&D	19	53	72	26	36					206
	20 Flights		5	27	197	177	91	1			498
Inspection											
	T&D	19	70	74	26	39					228
	20 Flights		5	28	193	170	89	1			486

E. References

1. Boeing Document D2-80907, Configuration Control and System Definition, X-20 Military Capability.
2. Boeing Document D2-80834-1, X-20 Military Capability.
3. Boeing Document D2-80884-2, X-20 Military Capability.
4. Deputyfor Technology (SST), SSD, paper in response to Secretary McNamara's 15 March 1963 questions, Vols 1 and 2, SSTS-85, 10 May 1963.

(C) PHASE O STUDY OF X-20 FOR PROGRAM 706

A. Introduction

ASD (X-20 System Program Office) was requested by SSD in July 1963 to conduct, as part of the 706 Phase O studies, an analysis which showed the capability of the X-20 and/or modified X-20 for the 706 (Satellite Inspector) mission. Under CCN-50 to contract AF33(657)-7132, The Boeing Company performed a system analysis and synthesis, while under CCN-16 to contract AF33(657)-7133, the Minneapolis-Honeywell Regulator Company conducted a conceptual control and guidance study. In addition to over-all study management and technical integration responsibility, the X-20 SPO conducted a manned capability study as an in-house effort.

Funding level for the contracted studies was $250,000.

B. Objectives

To conduct Phase O conceptual system studies and analyses of satellite inspection systems which utilize the X-20 spacecraft, and to provide technical and programming data which will:

1. Establish system design criteria and performance requirements.

2. Define technical alternative system and subsystem design configurations so as to permit trade-off decisions and evaluation against other systems.

3. Establish a basis for cost and reliability estimates.

4. Define objectives and features of the over-all system design.

5. Identify major modifications to the T-III launch vehicle and X-20 spacecraft.

6. Formulate program plans for Program Definition, (Phase I), and development, test and evaluation, (Phase II).

C. Scope and Limitations

The scope of this study was to perform conceptual design studies of two basic approaches for an inspection system which will fulfill as many of the inspection mission requirements as practical. The first approach, configuration A, was an X-20 spacecraft incorporating its own maneuvering propulsion system launched by Titan III. The second approach, configuration B, used the Titan III transtage for both launch and on-orbit propulsion. Both one and two man configurations were to be considered with mission duration capability up to 14 days. Military sensor payloads

were defined, as well as the ground tracking and data recovery complex. Two inspections of the target during a 24-hour station keeping period with minimum data-return lag were specified.

Manned capability considerations included (1) manned vehicle design considerations, (2) rationale for the use of man, and (3) a function/task analysis.

D. Conclusions

1. The X-20A glider can be modified to accommodate either a one or two man crew for a 14 day duration mission. For the 2 man, 14 day mission, configuration B' maximum altitude capability range is 800 to 1,000 miles, (depending on glider weight). Configuration B' is the more desirable, having greater altitude capability than A', and also less development cost. Both provide a capability for single-step de-orbit from 600 n. mi. and conventional landing at any major Air Force Base. Feasibility of a one-man, 36 hour satellite system with target intercept capability up to 1300 n. mi. was indicated.

2. An inertial guidance subsystem can be synthesized with in-orbit up-dating accuracies adequate to perform inspector mission requirements with the X-20X spacecraft. Through improved design, reductions in weight, volume and power over the X-20A subsystem can be achieved.

3. Either a one or two man crew in the X-20X can perform the stipulated 14-day missions. However, the function/task analysis indicated that a large percentage of the time in orbit during the 14 days would be spent in waiting, and thus would be non-productive. (This situation may have been due to the lack of detail mission requirements). The analysis indicated that a one man configuration could effectively accomplish an equivalent mission in 36 hours; a two man configuration could possible provide more data acquisition capability. The crew can accomplish all task requirements if provided the proper equipment and controls. The analyses made during the Phase 0 study indicated that a simulation study should be initiated during Phase 1 to evaluate man's ability to operate and maintain specific mission equipment to be used in the X-20X.

The Phase 0 analyses may result in a requirement for a different and perhaps more realistic approach for the utilization of man in space; (autonomous, orbital navigation and target acquisition, crew decision-making concerning the intelligence data obtained during inspection). This has great effect on communication and other subsystem requirements of the X-20X system. A realistic estimate is required of all target counter-measures capabilities confirmed by the Foreign Technology Division. Air Technical Intelligence. These data are required to determine alternative methods of target acquisition and inspection by a satellite inspector weapon system.

A realistic approach must be developed for the utilization of man in: (1) autonomous orbital navigation and target acquisition; (2) crew decision making concerning the intelligence data obtained during the inspection and authority to act on the basis of this information. This has great effect on the communication requirements of the system.

Schedule and cost:

The schedule and cost were based on an integrated and extended X-20A R&D program. The test objectives of the flight test program were broadened and reprogrammed to include a series of tests designed to check the subsystems and sensors without compromising the objectives of the research program. Four (or five) additional flights were added using three new spacecrafts to demonstrate satellite inspection capability.

Schedule:

Phase 1 start August 1964
Phase 1 complete February 1965
Phase 2 start April 1965
First launch September 1967 (Configuration A' and B')
Last launch August 1969 (Configuration B')

Costs:

Configuration B'
Phase 1 (most likely) FY 65 - 4.2 millions
Phase 2 (most likely) FY 65 through FY 70 - 324.0 millions.

E. References

1. (C) ASD X-20 SPO Report, Phase 0 Study of X-20 for Program 706, Volumes I - V, 63ASZR-1890, dated 18 November 1963.

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Resume V

DYNA-SOAR MANNED MILITARY SPACE CAPABILITY STUDY (MMSC)

The purpose of these studies was to define the technical development and program planning necessary to conduct a military space program with the following objectives:

1. Provide a technological basis for manned maneuverable system operating in the hypersonic and orbital flight regimes.

2. Demonstrate the military capabilities of a manned orbital vehicle.

3. Determine by analysis, applied research, and advanced technology testing, the optimum configuration for manned super-orbital vehicles.

4. Determine the military mission and equipment requirements for super-orbital operations.

The studies were conducted by a joint ASD and SSD team under direction of Air Force Systems Command during June through September 1961. Results are summarized in a development planning report, 61ASZR-1500, dated 7 October 1961 propared by the X-20 SPO.

Conclusions (Technical)

It was concluded that the following approach should be followed in providing a manned space capability:

1. Re-orient an accelerated X-20A program to demonstrate a manned military space capability, with particular emphasis on the satellite inspection and intercept role.

2. Initiate a Dyna-Soar Phase Beta study having as its purpose the determination of the vehicle configuration best suited for super-orbital military operations. This study should include all of the total-system aspects inherent in the development of a weapon system and be based on a model change in the Dyna-Soar rather than the adoption of a completely new vehicle program

3. Realign applicable advanced technology and applied research programs to assure maximum benefit to the Dyna-Soar MMSC program.

Schedule and Cost

The study showed that with proper phasing of X-20 technical development, the Phase Beta studies and the supporting research and technology, first piloted orbital flight could be initiated three and one-half years after redirection of the Dyna-Soar program. An 18-flight test program

was proposed in which both military subsystem testing and preliminary super-orbital testing could be accomplished with a property modified X-20 glider, the Titan III booster and the range facilities used for the X-20A program.

The estimated cost of the program was $1.1 billion of which $921 million were allocated to X-20, $66 million to applied research and $146 million to advanced technology.

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Resume VI

SR 178, "GLOBAL SURVEILLANCE SYSTEM"

The objective of this study was to determine the design characteristics of a manned, recoverable, reconnaissance satellite system, to select an optimum design concept, to identify the applied research and development necessary and to prepare a development program for such a system. This study was conducted under the direction of the Directorate of Advanced Systems Planning, Aeronautical Systems Division, Wright-Patterson AFB. As a result of a preliminary Phase 1 study in 1959, the ground rules and four study contractors and an ASD Team were selected for conduct of a Phase 2 study in 1960 and 1961. Results of this study are given in ASD Technical Report 61-532, dated 1961 (November). The ground rules from Phase 1 included, low earth orbit, a fully recoverable vehicle, crew of 3 to 6. Force size should be small (about 4 vehicles in orbit), multiple sensor payload, identification of the role of man, and assumed IOC of 1968 to 1970.

Conclusions (Technical)

The final evaluation of SR 178 selected a configuration of a 4-man winged re-entry vehicle of the Dyna-Soar type in conjunction with an in-orbit module as the recommended choice. Other conclusions were:

a. Military sensors considered feasible for an IOC in 1968 to 1970 time period (provided sustained engineering effort was maintained in their development) are:

1. High resolution camera, 3' resolution.

2. Imaging infra-red camera, 75' resolution.

3. Imaging radar (side-looking), 25' resolution.

4. Ferret (ELINT/COMINT), 1/3 of full spectrum from 10 mc to 100 gc in one vehicle.

b. A manned, recoverable, multi-sensor reconnaissance satellite is feasible provided:

1. Aggressive development is started quickly in the critical technical areas of bioastronautic (weightlessness, solar flares), crew-return vehicle design, high resolution camera, imaging radar, and ELINT.

2. The crew can tolerate zero G environment.

3. Solar flares can be predicted or shielded against.

4. Vulnerability is not considered unsurmountable (from more study).

5. The problem of cost can be resolved for critical development items and reduction of launch vehicle costs.

c. The value of man in the vehicle is, in order of approximate importance:

1. Maintenance, without which reliability would be unacceptable.
2. Pre-analysis and selection of data to be transmitted.
3. Flash-transmission of information by secure link with ground.
4. Exercising judgment in emergency situations.
5. Responding to ground commands.

d. There is probably an advantage in correlated multi-sensor data over that obtained from several single-sensor satellites, but the relative cost effectiveness was not firmly established.

Schedule and Costs

A typical schedule identified the first development launch at the end of the fourth year after program initiation, with first manned launch one and one-half years later. A typical program cost developed by this study, assuming one vehicle in orbit continuously, was determined to be $2.3 billion.

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FIVE YEAR SPACE PLAN

USAF Space Program

The USAF space program was prepared in 1962 within AFSC for the Air Force with SSD as the lead division. In the period from March to August 1962, numerous studies were conducted by the AFSC teams to evaluate the capabilities of various systems and components versus the national requirements. The product of this effort was a compilation of proposed programs for the 5-year duration in the form of Program Change Proposals (PCP's, DD Form 1335-1).

X-20 was considered for such missions as Request Reconnaissance, Satellite Inspection and Space Station Shuttle. No firm recommendation was made by Hq USAF for using X-20 as an operational weapon system.

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Resume VIII

(S) X-20 ANTI-SATELLITE MISSION

A program-planning report which considered a modified X-20 to give interim operational capability of a piloted satellite inspection and negation system was prepared from the information contained in "Response to Secretary McNamara's 15 March 1963 Questions." The modified X-20 was to demonstrate capability at the earliest possible date in near-earth orbits, and to use suitable components and subsystems developed in current programs. Purpose of the program was to define a logical development procedure for a fully operational space system for satellite inspection and negation against real threats in the 1970 time period. A report entitled, 'The X-20 Anti-Satellite Mission" was prepared by the X-20 SPO in response to AFSC message SCLDS-23-5-8, dated 23 May 1963, and released on 1 June 1963 (63ASZR-1022).

Conclusions (Technical)

An interim operational capability of an inspection/negation system was considered feasible and attainable by the 1968 time period.

The current X-20A program could be readily and economically modified into a program for the development of an interim inspection and negation system because of vehicle payload and return capability and the timeliness for switch-over.

A re-orientation of the present program would incur the least cost and shortest completion time as compared with a later redirection or the initiation of a new program.

A limited operational capability of inspection and negation could be achieved following the X-20 IOC program. A fully operational system would probably require further Phase 0 conceptual studies to determine the real threat, the operational concept, and the force structure.

Schedule and Costs

The presently planned X-20A vehicle could be modified and the system test program re-oriented to accomplish inspection sensors and subsystem testing on six multi-orbit flights. Two additional flights would be required to demonstrate the ability of the X-20A spacecraft to accomplish the inspection and negation mission.

Schedule:

Phase 1 approval - early 1964
Phase 2 approval - mid 1965
First sensors test flight - early 1967
Last mission demonstration flight - late 1968

Costs:

Modified X-20A Program - 227 million
50 Launch Operational - 1229 million
(10 Flights per year for five years)

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Resume IX

PRESIDENT'S SCIENTIFIC ADVISORY COUNCIL QUESTIONS

PSAC Presentation

During September-October 1963, the Space Vehicle Sub-Committee of the President's Scientific Advisory Council (PSAC) under the chairmanship of Professor Lester Lees of California Institute of Technology was asked to look into the capabilities and justification of space systems, particularly those which might lead to or associate with an orbital space station. X-20 was one of the major systems to be considered. The sub-committee's interests were centered on a number of specific questions. These were:

1. Why military must go to space ?

2. Why should it be manned?

3. What are the tests which must be done in space rather than on the ground?

4. What tests or experiments can X-20 perform?

5. What can X-20 do towards an orbital space station?

The above questions were answered to the committee in the Executive Mansion, Washington DC, on 10 Oct 1963.

Conclusions

Current X-20 Program
Highly integrates man/machine
Includes extensive ground simulation tests
Provides criteria for man/machine integration
Provides data on value of man for orbital and lifting reentry flight,

Current X-20 configuration provides capability for orbital test and return of a large variety of military equipments.

Orbital tests of military equipments can be added to the currently programmed reentry tests.

Modifications of X-20 can be made to increase orbital duration/capacity and extend capability for:

Extensive Military subsystem and man's value tests
Military mission explorations

This report is classified SECRET because it discusses specific military applications of the X-20 System.